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Detection of Incipient Army Criminals

Gilbert L. Betts

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The Detection of Incipient Army Criminals

Gilbert L. Betts, *Editor,*
Educational Test Bureau, Minneapolis, Minnesota

THE SELECTIVE SERVICE SYSTEM IN operation during the late war delivered selectees to the Armed Forces Induction Stations, where they were examined to determine whether they met the War Department standards for induction. Failure of a selectee to meet prescribed standards resulted in rejection. Such action was based essentially on the assumption that unqualified selectees could not serve a useful purpose in the Armed Forces, but that qualified selectees could.

The standards were roughly of three kinds: physical, mental, and moral. Examinations in all three fields were at first made by medical doctors, but as personnel needs became more acute and finer discriminations became necessary, nonpsychiatric mental examinations became the specific responsibility of professional psychologists. Responsibility for moral examinations, however, was never clearly delegated to specialists in this field.

As the war progressed it appeared that induction station screening procedures were, in general, fairly satisfactory in the physical and mental fields; but the Army prison population increased rapidly. Overcrowding in disciplinary barracks and rehabilitation centers became worse and worse, despite the regularly increasing number of such installations—a state of affairs indicating that screening procedures to prevent the induction of these men were not entirely satisfactory.

The situation was further complicated by a War Department provision that Selective Service registrants with other than honorable discharges from the Armed Forces, registrants currently undergoing confinement, and registrants with prison records might be inducted after approval of the Service Commander had been secured. In the 7th Service Command the responsibility for granting this approval was delegated to the Personnel Division in the Service Command headquarters.

The difficulty was most acute in connection with applications for induction from registrants currently undergoing confinement. At first the short, running case histories accompanying these applications were evaluated subjectively and applications either approved or disapproved accordingly. These case histories varied widely in completeness, and some were much more persuasive than others. This element of persuasiveness was one with which it was particularly difficult to deal. Finally, under special War Department authority, the development of improved procedures was undertaken.

From an address delivered at the annual meeting of the American Educational Research Association, Atlantic City, New Jersey, March 3, 1947.

A Preliminary Procedure

A search of the literature revealed that several studies had been made by sociologists in predicting success in the probation and parole of civilian prisoners. From published data a Case History Check Sheet was constructed for preliminary use in evaluating the case histories submitted with applications from corrective and penal institutions. By means of this sheet and the accompanying parole violation expectancy table, a running case history could be evaluated quantitatively. It was assumed that a potential parole violator would also be a poor Army risk. This device was found to be a great improvement over the unaided subjective evaluations made previously; but inasmuch as it was based on data from a civilian population and its use rested on an unverified assumption, and because it was not well adapted to routine induction station use, steps were taken to develop a still more satisfactory procedure.

In using the Check Sheet it was noted that half or more of the items included pertained to circumstances and conditions of life *prior* to imprisonment. Since these items had been shown to have a significant predictive value in relation to parole violation *after* a term in prison, a more comprehensive list of such items could be employed in the contemplated device. Eventually a psychological rather than a sociological procedure was decided upon, *i.e.* judgment was to be based upon the reactions of the selectee himself made on the spot. Analysis of the psychological principles involved indicated that nothing would be lost and much might be gained by using items having a sociological connotation.

Psychological Principles Involved

Maladjusted, antisocial behavior in an adult is learned behavior, constitutionally permitted but not so caused. Such behavior was learned and became habitual through the mechanism of trial-and-error responses to recurrent, emotionally charged, stimulus situations. In the 18–20 years leading into adulthood, behavior patterns become firmly established and cannot be shed at will; they must be unlearned. Unlearning and relearning may require the presence of remedial situations as potent and as long standing as were the originals.

With respect to these circumstances of life, variation must be considered. Furthermore, concomitant variation

among the following factors is probable: (a) occurrence of unfavorable stimulating situations up to a given date, (b) seriousness and extent of maladjustment, (c) chances for prompt imprisonment, and (d) chances for prompt rehabilitation or spontaneous readjustment. If concomitant variation among these factors is a fact, status in one can be estimated when it is known in another. For example, a measure of (a) can be used to estimate (c). This particular relationship was relied upon in developing the improved technique. More specifically stated, it was assumed that selectees arriving at an induction station with a self-related history of experiences characteristic of Army prisoners, but not of normal operative personnel, may be expected to become prisoners promptly. Inasmuch as they would then serve no useful purpose, rejection would be the indicated action.

Developmental Technique

The technique employed to develop and calibrate this measuring instrument was relatively simple. From a survey of the literature a comprehensive list of descriptive items were assembled and arranged in multiple-response, single-choice form. The following examples illustrate the form of these items:

1. The number of members in my family that have been sent to a mental hospital, prison, or other institution are—
   a. none
   b. one
   c. two
   d. three or more
2. In the past 5 years I have been in trouble from fighting—
   a. not once
   b. once
   c. twice
   d. three or more times
3. As a child my parents were—
   a. always very strict with me
   b. usually very strict with me
   c. seldom very strict with me
   d. never very strict with me

Available evidence indicated that each of the items so assembled was significant in relation to social adjustment or maladjustment.

Responses to items in this experimental form, called the Biographical Case History, were secured from two contrasting criterion groups of Army personnel. The first consisted of 1,177 general court martial prisoners, inmates of the U. S. Disciplinary Barracks at Fort Leavenworth, Kansas, and the Rehabilitation Center at Camp Phillips, Kansas. The second group consisted of 1,050 enlisted men from the operative personnel of reception centers in the 7th Service Command.

The number making each response, in each criterion group, was determined. These numbers were converted to proportions, and, by comparing proportions of each criterion group, item by item, the 67 items showing the largest differences were selected to constitute the final form. Among these 67 items the smallest difference between proportions was .141. The standard error of this difference was .020, the critical ratio thus being about 7. Each of the remaining 66 items had even greater discriminating power. As usually considered, this is internal evidence of validity.

External evidence was also obtained. From the proportion of cases in the two criterion groups making each reply, a scoring key was so arranged that a credit of one point was allowed for each reply characteristic of normal soldiers but not of prisoners. A group of 1,366 prisoners (1,117 general and 249 garrison) was separated into two divisions, one consisting of 580 first offenders and the other of 786 recidivists. Statistics from these two divisions are given in Table 1. From these statistics the difference between the two means and its standard error are found to be 6.43 and .48, respectively, giving a critical ratio of about 13.

TABLE 1

Measurement Statistics on Army Prisoners Separated Into Two Divisions

Group	Cases		Mean score	S.D.
	No.	Proportion		
First offenders	580	.424	34.45	8.83
Recidivists	786	.576	28.02	8.81
Total	1,366	1.000	30.75	9.37

It is assumed that maladjustment varies from little or none, through an amount causing the first offense, into a greater amount causing repeated offenses. The two divisions of prisoners therefore represent two segments on a continuum. If it is further assumed that the distribution of maladjustment in the prison population approximates the normal curve, then obtained measures of maladjustment can be correlated with the criterion, using the formula for biserial r. Believing that these two assumptions are warranted, such a coefficient was derived from the data given above. The correlation is .428, its standard error, .029, and the critical ratio, almost 15.

This is a rigorous test of validity, because the range of maladjustment in the prison population is restricted to a small fraction of the range existing in the total population. Subsequent information indicates that the spread between the means in the normal and prison population is about equal to the spread in school achievement between the means of three school grades. Furthermore, the instrument must measure (as it does) over a total range approximately equivalent to an 8- or 9-grade range in school achievement. Therefore, if the validity coefficient in the restricted range were corrected for the total range within which the instrument must be used, it would be unusually high.

Calibration

Several questions had to be answered before standards could be constructed with dispatch. One question was: Must second and independent samples be drawn for calibration purposes? To answer this question, second, independent, but smaller samples were actually drawn, and means and standard deviations from the two samples were compared to see whether they differed significantly. The statistics are given in Table 2. Both critical ratios pertaining to the means are less than 2.0, and both pertaining to the standard deviations are less than 1.0. Thus, by the usual criterion for the significance of differences, it appeared unnecessary to draw second independent samples for standardization purposes.

TABLE 2

Measurement Statistics on Two Samples Each of Normal Operative Soldiers and Imprisoned Soldiers

Item	Mean	S.D.
Operative soldiers		
Sample 1 (1,050 cases)	47.65	6.79
Sample 2 (116 cases)	48.58	6.86
Difference	0.93	0.07
Standard error of difference	0.67	0.47
Critical ratio	1.9	0.1
Imprisoned soldiers		
Sample 1 (1,177 cases)	30.24	9.30
Sample 2 (130 cases)	31.85	8.85
Difference	1.61	0.45
Standard error of difference	.82	0.58
Critical ratio	2.0–	0.8

The second question to be answered was: Do standards based on normal operative personnel in the Army apply sufficiently well to selectees arriving for induction? To answer this question, measures were secured from a cross-section sample of arriving selectees and comparison made, as before, between the means and standard deviations in the two groups (Table 3). The difference of 1.5 points between the means, although statistically significant, was considered unimportant operationally in relation to the difference of 17.4 points between the means of operative and imprisoned personnel. The standard deviations were almost identical. For calibration purposes the two samples were combined (1,581 cases).

TABLE 3

Measurement Statistics on Normal Operative Soldiers and Selectees

Item	Mean	S.D.
Operative soldiers (1,050 cases)	47.65	6.77
Selectees (531 cases)	46.10	6.79
Difference	1.55	0.02
Standard error of the difference	.36	.25
Critical ratio	4.3	.0+

The third question to be answered was akin to the second: Do standards based on general court martial prisoners apply sufficiently well to garrison prisoners also? Measures were secured from a group of garrison prisoners, including both the sentenced and the unsentenced, and means and standard deviations were compared as before (Table 4). Since both critical ratios are less than 3, the differences were considered insignificant, and the two samples were combined for calibration purposes. For the normal group (1,581 cases), the mean was 47.13 and the standard deviation 6.81; for the imprisoned group (1,426 cases), the values were 30.42 and 9.51, respectively.

TABLE 4

Measurement Statistics on General Court Martial Prisoners and Garrison Prisoners

Item	Mean	S.D.
General prisoners (1,177 cases)	30.24	9.28
Garrison prisoners (249 cases)	31.27	10.46
Difference	1.03	1.18
Standard error of the difference	.71	.51
Critical ratio	1.5	2.3

In view of the constant military use of the term "calculated risk" and in view of the necessity for always either accepting or rejecting a selectee for induction, calibration took an unusual form. From the data given above, a pair of probabilities was derived for each possible score: (1) that a selectee would become a normal operative soldier and (2) that he would become an Army prisoner. Although these probabilities are the proportion of cases lying in the tails of the two distributions beyond a given score, the proportion in the lower end of the operative distribution and in the upper end of the prison distribution was taken. Thus, the higher the score, the greater the probability that the examinee should be classified as a prospective operative soldier and the less that he is an incipient Army criminal, and conversely.

Each pair of probabilities was further converted to a base of 1.00; that is, if the pair of chances were 16 to 16, it was considered equally appropriate to say that this represents a .50-.50 chance. Whatever pair is taken in this case, the sum is always 1.00. This is the underlying procedure followed when one has an equal admixture of successes and failures in a single normal distribution of such scores that high is predictive of success, and low of failure. In such a distribution the chances are .50-.50 at the median, .25-.75 at the upper quartile point, and .75-.25 at the lower quartile point.

With calibration in the form of paired probabilities related to two contrasting criterion groups, the critical score may always be set in accord with the amount of risk considered appropriate at the moment. Such a continuum rests squarely upon the criterion and is not merely connected with it loosely through a supplementary validity coefficient. With such a continuum the criterion becomes functional, not merely descriptive.

Utilization

Records were examined concerning the use of the Biographical Case History in the 7th Service Command during the 18-month period, March 24, 1944–September 24, 1945. The records indicate that 4,278 selectees with previous criminal records were examined. Of these, 57 per cent, or 2,438 cases, were rejected for failure to meet the moral standards for induction. The average raw score for these rejects was between 33 and 34. The pair of percentages for score 34 is 92:8. That is, one could expect 92 per cent (2,243), had they been inducted, to become moral casualties and be imprisoned.

In addition to these men, 356 made application to the Service Commander for a prior moral waiver. Of these applicants, 168 were rejected. Their average raw score was 28. Reasoning as above, 99.6 per cent probably would have become moral casualties had they been inducted. Adding these to the previous figure gives a total of 2,410 incipient Army prisoners kept by the 7th Service Command from entering the Army during this 18-month period.

Case records of moral casualties in Army prisons indicate that most of their stay in the Army represents a loss. It has been estimated that the cost of each psychiatric casualty, from inception to cure or death, in World War I averaged $30,000. Many of the elements of cost in moral casualties are the same as in psychiatric casualties.

Case records of general prisoners show rather uniformly a series of minor offenses leading eventually to a serious offense and a general court martial. If these men get into theaters of operation, they cannot be depended upon to accomplish a mission. Their failure causes the destruction and waste of material and equipment and the loss of other lives. Thus, the money spent on them routinely for induction, transportation, food, clothing, shelter, medical care, training, and equipment is sheer loss. An estimate of $1,000 each from this source is considered extremely conservative. To this must be added the cost of their apprehension, transportation, trial, confinement, and all other matters incidental to their offenses. A cost estimate of $1,000 each from this source is also considered very conservative.

Even so, at $2,000 each, the estimated money saving to the Army through the use of the Biographical Case History over an 18-month period in only one of the nine service areas, is almost $5,000,000. If the average cost of a moral casualty turns out to be equal to the cost of a psychiatric casualty ($30,000 instead of $2,000 each), this estimate would rise to over $67,000,000.

Implications

Dealing scientifically with the problem of crime resulted in monetary benefits to the Armed Forces. Similar benefits may be secured in civil life. Business and industry, for example, would find it equally profitable to avoid the employment of incipient criminals. The Biographical Case History used in induction stations can be converted to a quantified personal history sheet and used in employment offices. With it, psychologists can select morally qualified personnel for business and industry, taking whatever chances are deemed appropriate under the circumstances. Furthermore, through use of appropriate criterion groups and statistical procedures an instrument may be devised for detecting persons predisposed toward a particular type of crime. Certain types of crime are crucial in connection with certain jobs. It is quite undesirable, for example, to hire incipient embezzlers as cashiers or pilferers as watchmen.

Selection of all kinds, however, is merely a procedure enabling one portion of society to avoid the cost of crime. If crime exists, so does its cost. If a portion of society avoids this cost, the burden is increased for the remainder. The problem is prevention, not avoidance. But prevention is the negative side of the case. Stated positively, the problem is that of promoting moral living.

The field of morality lies in the twilight area between saintliness and crime. In the study here reported certain circumstances of living were found to be antecedent to crime. If these antecedents are removed, is crime prevented? If the antecedents of saintliness were discovered and more abundantly provided, would morality be increased? From present knowledge about cause and effect, the answer to both questions appears to be "yes." An effective program of action, therefore, would operate in two directions: (1) to eliminate circumstances of living that lead to crime and (2) to provide more abundantly those circumstances of living that lead to greater morality.

Three of the principal agencies concerned are the schools, the churches, and the social welfare agencies. With a device such as the Biographical Case History, schools can detect incipient delinquents and at the same time discover the particular patterns of living that are causing delinquency in individual cases. In cooperation with the churches and social welfare and other agencies, steps can be taken to alleviate these circumstances. Of the three agencies mentioned, however, the churches have the greatest opportunity.

The scientific method is universally applicable. It is a problem-solving procedure that may be applied in any field where problems exist. In physical science this procedure has yielded atomic energy and vastly increased the destructiveness of war. With less funds than are now spent on physical science, social science can accomplish equally great things, at greater present profit for society. If incipient criminals of lesser grade can be detected and the inciting circumstances of living removed, it should also be possible to detect incipient war criminals and remove the causes of war. Furthermore, in the continuous climate of peace that can be provided by social science, physical science can serve constructive ends unceasingly.

New Horizons in Archaeology

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THE ADVANCEMENT OF SCIENCE IN THE past century has clearly demonstrated the fact that the progress made in any one field is dependent upon that made in associated fields of study. In no instance is this more noticeable than in the field of archaeology. We all accept the fact that mathematics and geology are among the "ancients" in science, but we are apt to forget that archaeology is older than any of these. Man, with his interest in the past, has for thousands of years manifested an interest in the events and progress of those who preceded him. A close study of all of the "greats" in ancient science will reveal their interest in old remains and the lives of those who lived before them. Even among the savage tribes we find this same interest in the past. Thus, it is safe, I believe, to list anthropology among the first of the sciences to be studied.

Anthropology is a study which uses all of the sciences as tools. It is difficult to name any field of endeavor which has not been studied by the anthropologist in an attempt to reconstruct the history of mankind. Then, in turn, when the material has been evaluated, it is the chemist or metallurgist who takes the early history of his subject and uses it as a basis for later development.

The methods of the early worker in anthropology were, of necessity, crude. Unfortunately, in the case of archaeology the scientist is given but one chance. The story of man's past is written as though upon ancient parchment which crumples when exposed to the air. One careless excavation, loss of the description of a discovery, and the knowledge of that specific site is lost to the world forever. This unique position has for many years made archaeologists a clique of scientists who have not invited the eager diggings and examination of uneducated laymen. Year after year they have seen thousands of pages of history torn to bits for the price of a pretty piece of pottery or a shiny bracelet.

As the brother sciences advanced, so did the study of ancient man. The correlation of archaeology with the other sciences is now such that, to be an archaeologist, one must be, in the most general terminology, a scientist. In order to solve the mysteries of the ancient red man, for example, it has become necessary to turn to geology, botany, physics, mathematics, and numerous other disciplines. All the great archaeological advances made in America in the past century are due to the intelligent use of methods developed in other sciences.

A study of the food of the cultures of America has occupied many of the best men in that field. The association of food areas with migrations was determined and aided in the study of the problems of archaeology. The study of climates and early man by noted meteorologists has added much to our knowledge of ancient life. Studies of basketry, clothing, and ceramics have enlisted the aid of many persons not otherwise interested in archaeology and, in turn, have interested the archaeologist in subjects previously unknown to him. Art designs and early means of writing have led to very involved studies and attempts to decipher these early written languages. Remains of temples and other ruins have led the archaeologist to the architects in order that these might be reproduced intelligently and the mystery of their use solved. Early work in stone and manufacture of paints, glue, cement, maps, poisons, medicine, etc. have caused archaeologists to put down the spade and begin a study of the above subjects in order to understand their discoveries. The specific knowledge so vital to the archaeologist is that which will enable him safely to discover and remove for posterity these pages of unwritten history.

In this field more has been done in the past century than in all of the previous history of the world. Aerial photography has revealed to the student the location of numerous sites in regions before unmapped. In other regions it has revealed terrain features not noticeable from the ground. Once located, modern cameras and a professional knowledge of the subject have enabled accurate recording of the progress of the excavation with greater detail than sketching could ever afford. Application of tree-ring dating methods have been used to date numerous sites in the Southwest by study of the timbers used in ancient ruins. Mathematical and qualitative studies of pottery distribution have led to their use as a dating device. Geology has been applied to settle difficult problems of great age, possible only by knowledge of strata relations.

Following excavation of the site, by use either of the spade and brush or of more modern methods involving elaborate machinery for removal of fine sand or large quantities of dirt, much remains to be done. It is here that the numerous resources now available must be applied. Special devices for photographing the interior of pottery vessels have been placed in operation. Methods

From a paper presented before Section H, AAAS Boston Meeting, December 26, 1946. The statistical analysis described by the author was conducted with the aid of grants from the American Philosophical Society and the Washington Academy of Science.

for the removal of layers of paint on walls of dwellings, used over a period of years, have been helpful in preserving what would have formerly been destroyed. In the laboratory, ancient seeds and fruits have been studied, chemicals and paints analyzed, and pottery mixtures reproduced.

Although plans are being formulated for exploration of sea floors in search of lost cities and the use of diving apparatus has been demonstrated in Mexico, the new horizons of archaeology lie neither there nor in the unexplored countries from which we hear daily of the discovery of subhuman links. The new horizons of archaeology lie in the development of methods and practices fully applicable to all sciences. With but few exceptions the problems of archaeology are well known. We now know where the missing links should be located, the eras for which little has been found, the areas that are barren, and the material in the museums that now is of little value. As the era of large excavations for the purpose of stocking museums passes, the serious student of archaeology looks to the small sites and the ancient finds, where often little is found. It is his job to make the best utilization of the little he does find in order to rewrite as much of the story as possible.

One of the best examples of this type of material is the petroglyph or the numerous designs known as picture writing. Throughout the United States, as well as throughout the world, these designs are known. From Alaska to Mexico and from the Pacific to the Atlantic the walls of canyons are covered with the crude or elaborate pictures of the ancient American. Many of these are godlike figures towering 10 or 12 feet above the observer, while others are small designs carved on the surface of boulders in rivers in the hope of bringing added luck in fishing. Others in caves are painted in red, yellow, and blue and depict the scenes of tribal life. On numerous canyon walls as many as three or four different designs have been superimposed on others, the whole series covering a period of a thousand years. For many years, when archaeologists had great masses of material to excavate, these designs were ignored. For a while the early settlers of America thought that the designs were made by early explorers from Norway, eastern islands, or even Egypt. In some cases hundreds of books were written to describe these sites, and even duels were fought by those having different theories. As time passed and more sites were found where the only evidence of man's occupation was these strange "doodles," the archaeologists became more interested in making use of these designs as a key to the makers.

As art, pottery, and foods in different areas vary, so is there difference in designs. In some cases the simple designs, such as circles, squares, etc., were universal in their distribution. Others, however, like the quaint flute player of the Southwest, the water monster of Pennsylvania, or the masked dancers of Utah, formed a basis for constructive analysis. The material was so scattered and vast in amount that many workers became discouraged and left the task to others. With the general introduction of the method of qualitative analysis by A. L. Kroeber, of the University of California, the study of petroglyphs was approached by one of his fellow professors, Julian Steward, who in the 1930's began a qualitative analysis of the subject in an effort to make this vast amount of material available to archaeologists. By the use of some 50 typical designs ranging from simple lines to complex maps, Dr. Steward began to study the sites of California. As he had expected, the typical designs varied with geographical location, and in some cases his areas, as determined by the simple designs on canyon walls, agreed completely with those determined by the longer task of excavation and years of research. With the publication of his results the archaeologists of the United States began to dig from their files the old photographs and sketches of the petroglyphs of their respective states. Their work soon revealed, however, that in certain cases the material at hand must be handled by more definite means.

In the hope of testing a new method as well as continuing a study of petroglyphs, the author applied the statistical method in a formal manner to the same material first used by Dr. Steward. As was expected, the application of this subject proved that the correlation suspected and proved by Dr. Steward did exist and could be mathematically shown to exist. In addition, the results served to answer the questions raised by Dr. Steward's survey and revealed the usefulness of the application of statistics. In California and later in other states it has been possible to define the limit of cultural areas and in some cases to define the most important time relations—all by use of the simple designs so similar to the telephone "doodles" of today.

The application of statistics in this specific instance has been of value to the archaeologist in the study of material where such evaluation can be made. As many of the finds of the archaeologist are of this type—pottery, artifacts, and cultural traits—use of the method will lead to new and better comprehension of old data. In the museums and colleges of the United States numerous files of material are available for study in the light of new methods. When it is possible to make maximum use of all the data found at a site, from the smallest picture to the largest piece of pottery, we will be able to rewrite the story of the early American.

Although modern devices enable the archaeologist to make more comfortable expeditions and simplify the task of excavation, it is in the realm of analysis of material discovered that the new advancements will be made. Through proper use of statistical and qualitative methods all types of data, formerly discarded, may now be studied. The increased use of such methods has caused the scientist to look eagerly toward new horizons.

Association Affairs

Scientific Exhibits

The Advisory Committee for the AAAS Chicago Meeting has announced the availability of space for scientific exhibits, together with application procedures. The scientific exhibits will be housed with the technical exhibits in the Stevens Hotel, which will also serve as the main registration center for the meetings.

The Advisory Committee recommends that there be a wide variety of selected exhibits which will (1) portray scientific advances in the various fields of science; (2) show new techniques and apparatus usable in the laboratory or in classroom teaching; (3) summarize research in a given field. The Committee feels that personal demonstration is the most important single factor for a successful scientific exhibit because of the mutual benefit which accrues to the visiting scientists and the demonstrators. Originality in planning the exhibit is encouraged. Charts, drawings, transparencies, specimens, and other materials can be shown in a variety of ways, using light and color judiciously. A large expenditure of money is not necessary.

In general, the space allocated for scientific exhibits will be 6 feet deep and 10 feet wide. The Committee may at its discretion allocate a greater width than 10 feet. The exhibitors pay the expenses of preparation, transportation, and installation of their exhibits. Special construction in the booth, extra tables, chairs, or other furniture can be obtained at regular rates from the decorating firm. Application forms for scientific exhibit space may be obtained from: Theo. J. Christensen, Director of the International Science Exhibition, AAAS, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Members of the Advisory Committee for the exhibition are: Robert Coghill, Abbott Research Laboratories; Gustav Egloff, Universal Oil Products Company; Ovid Eschbach, Northwestern Technological Institute; Lyman W. Higgins, Gaertner Scientific Corporation; J. E. Hobson, Armour Research Foundation; Paul E. Klopsteg, Northwestern Technological Institute; Harvey B. Lemon, Museum of Science and Industry; and M. W. Welch, W. M. Welch Manufacturing Company.

AAAS-George Westinghouse Science Writing Awards

The Managing Committee of the AAAS-George Westinghouse Science Writing Awards has announced the names of the judges for the current year. The Judging Committee will select one newspaperman and one magazine writer to receive a $1,000 prize each for superior science writing for the lay public during the period October 1, 1946–September 30, 1947. Members of the Committee are: Morris Meister, principal, Bronx High School of Science; H. L. Mencken, *Baltimore Sun* papers; Benjamin McKelway, editor, Washington *Star*; Rudolf Flesch, author and writer; Kenneth Olson, dean, Northwestern University School of Journalism; Detlev Bronk, chairman, National Research Council; Edward Weidlein, director, Mellon Institute, Pittsburgh; Edward Weeks, editor, *Atlantic Monthly*; and Clifton Fadiman, literary critic.

The prizes will be awarded at a dinner at the Stevens Hotel on December 27, during the 114th meeting of the Association.

Photography in Science Competition and Salon

Information and entry blanks for the Photography in Science Exhibition are now available for distribution to professional scientists who wish to participate. The exhibition, sponsored jointly by the Division of Graphic Arts of the Smithsonian Institution and the *Scientific Monthly*, is designed to bring together the various techniques of photography used by scientists in all fields of science, thereby extending its possibilities for development as a basic tool in research and teaching. Entries will be received in Washington from September 25 to October 15. Accepted entries will be hung in the Smithsonian Institution November 1–30 and will then be shipped to Chicago for display at the International Science Exhibition of the AAAS, December 26–31. The two divisions of the exhibition will be (1) black-and-white and (2) color. No entry fee is required, nor is membership in the AAAS a requisite. Members of the Judging Committee are: Lt. Alexander J. Wedderburn, associate curator, Division of Graphic Arts, Smithsonian Institution; Ralph D. Bennett, technical director of the Navy's new ordnance laboratory at White Oak, Maryland; K. M. Endicott, U. S. Public Health Service; Eleanor Parke Custis, internationally known photographer and salon exhibitor; and A. Aubrey Bodine, associate editor of *Camera* magazine.

After the exhibition closes at Chicago it will make a tour of museums throughout the country. Arrangements have been made to ship the exhibit to the Buell Planetarium in Pittsburgh immediately after the showing in Chicago. The next stop on the tour will be the Cranbrook Institute of Science, Bloomfield Hills, Michigan.

Science Theater

Reviving a prewar custom, there will be in the general exhibition area at the Chicago Meeting a Science Theater with seating capacity for approximately 50–75 persons at a time. The Advisory Committee believes that many recent research projects have been recorded on films or slides. It is felt that visitors to the meetings and the exhibition will want to have an opportunity not only to see the specific research films but also to learn more about the techniques of this method of recording research.

Advance solicitation of films and slides indicates that enough material should be available to last during the entire period of the meetings. Scientists who have or know about films that could be used are asked to send the information to Theo. J. Christensen, AAAS, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. A complete schedule of the films to be shown will be published in *Science* and the general program.

NEWS *and Notes*

The U. S. Zoological Park, Washington, D. C., has recently placed on exhibit four rare species of mammals from a collection made in the Philippine Islands by Charles Wharton. One of the most interesting species is *Tarsius carbonarius*, from Mindanao. Although there are 9 known species ranging from the Philippines to the East Indies, the 24 tarsiers of this species are the first to be exhibited in the United States. Some of the remarkable characteristics of this primitive primate, placed phylogenetically between the lemurs and the New World monkeys, are: expanded discs on fingers; folding ears; elongated tarsus for jumping; and tail for propping the animal. The three other rare species of mammals in this collection are: the tree shrew (*Urogale everettii*); Shadenberg's giant bush-tailed cloud rat (*Crateromys shadenbergii*) from the mountain forests of Luzon; and Cuming's giant cloud rat from the same locale. The first flying lemur to be brought successfully to the United States died in New York soon after arrival. The collection also includes 3 monkey-eating eagles, 1 white-breasted sea eagle, 1 serpent eagle, pythons, and lizards.

Section I (Psychology), will hold sessions Monday and Tuesday, December 29–30, at Chicago. Members wishing to present papers should send abstracts to the secretary, Harold E. Burtt, Department of Psychology, Ohio State University, Columbus 10, Ohio. Abstracts should be in triplicate (not over 200 words) and must be received by September 15 if they are to be considered. A program committee will decide which abstracts are acceptable and will prepare the detailed program. If slides, charts, or blackboard are necessary, a statement to that effect should be made at the end of the abstract. The time required should also be specified (maximum, 15 minutes). In the case of slides, it should be specified whether they are 2 x 2 or $3\frac{1}{4}$ x 4 inches. Moving pictures will not be shown in conjunction with any paper.

About People

Viktor Hamburger, professor of zoology, and chairman, Department of Zoology, Washington University, is visiting professor of zoology, University of Chicago, during the current summer session.

George H. Harding, formerly co-director of the engineering firm, Coulson and Harding, and president and general manager, National Air Surveys, Cincinnati, Ohio, has been appointed professor in the Department of Civil Engineering. Ohio State University, effective October 1,

W. H. C. Rueggeberg, Chemical Division, Chemical Corps Technical Command, Army Chemical Center, Maryland, is visiting England, Switzerland, and Sweden on matters of interest to the Chemical Corps.

Paul B. Sawin, associate professor of biology, Brown University, has been appointed research associate of the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, where he will continue his studies on the genetics of normal growth processes in the rabbit.

C. Richard Soderberg, deputy head, Department of Mechanical Engineering, Massachusetts Institute of Technology, has been appointed head of the Department.

A. E. Alexander, director, Gem Trade Laboratory, Inc., New York City, has just returned from Bahrain Island, Persian Gulf, where, at the invitation of C. Dalrymple Belgrave, C. B. E., adviser to the Bahrain Government, he investigated the genuine pearl fishing industry of the Gulf area. On his return, Dr. Alexander stopped in London to work with Basil W. Anderson, director, Precious Stone Laboratory, London Chamber of Commerce.

Pol Duwez, who has been doing research at California Institute of Technology since 1941, when he arrived from Belgium as a special Belgian-American Education Foundation student, has been appointed associate professor of mechanical engineering at the Institute.

Douglas F. Miner, formerly George Westinghouse professor of engineering, and assistant director, College of Engineering and Science, Carnegie Institute of Technology, has been appointed director, Division of Student Personnel and Welfare.

Thomas Hope Johnson, formerly associate director, Ballistics Research Laboratory, Aberdeen Proving Grounds, has been appointed head, Department of Physics, Brookhaven National Laboratory, and **Leland J. Haworth,** professor of physics, University of Illinois, has been appointed assistant director in charge of Research Projects at the Laboratory.

Henry Plenk, formerly of the University of Chicago Clinics and the Evanston Hospital Association, has been appointed assistant professor, Department of Radiology, University of Utah Medical School.

W. C. Coker, Kenan professor and emeritus head, Department of Botany, University of North Carolina, and **Ivey Foreman Lewis,** dean, College of Arts and Sciences, University of Virginia, were awarded honorary D. Sc. degrees at the June commencement of the University of North Carolina.

Julian F. Smith, formerly editor, Institute of Textile Technology, Charlottesville, Virginia, is now a scientist on the staff of the Office of Naval Research, Washington, D. C.

Grants and Awards

Leon S. Stone, Bronson professor of comparative anatomy, Yale University, received the Doyne Memorial Medal at the recent annual meeting of the Oxford Ophthalmological Society, Klebe College, Oxford, England. The award is in recognition of his work on retinal regeneration and vision experiments in transplanted eyes.

Percy L. Julian, formerly head, Department of Chemistry, Howard University, received the Spingarn Medal for his work in chemistry at the conference session of the National Association for the Advancement of Colored People. The presentation was made by Harold C. Urey, Nobel Prize winner, University of Chicago.

Mary Lura Sherrill, head, Department of Chemistry, Mount Holyoke College, will be the recipient of the Francis P. Garvan Medal, honoring women in chemistry, at the 112th national meeting of the American Chemical Society, to be held in New York, September 15–19.

The Committee on Scientific Research of the American Medical Association has recently made grants to Otto Saphir, Michael Reese Hospital, Chicago; Roger M. Reinecke, Department of Physiology, University of Minnesota; I. Davidsohn, Mount Sinai Hospital, Chicago; L. R. Cerecedo, Department of Chemistry, Fordham University; James H. Leathem, Rutgers University; H. O. Burdick, Alfred University, Alfred, New York; Ernest A. Spiegel, Temple University School of Medicine; Ben Vidgoff, Department of Pharmacology, University of Oregon Medical School; Ruth Silberberg, Barnard Free Skin and Cancer Hospital, St. Louis; and Harold J. Harris, New York City.

The first prize-winning thesis in the 1946 Schering Award, sponsored by the Schering Corporation, Bloomfield and Union, New Jersey, has been published in its entirety in an attractive booklet which is available upon request. The booklet is entitled "The Role of Hormones in Sterility," subject of the award, which was won by Bent Boving, Jefferson Medical School. The topic for the current 1947 Schering Award contest, which closed July 31, is "The Clinical Use of Androgens in the Female."

S. B. Penick & Company, New York City, manufacturers of botanical products and fine chemicals, have recently established five research grants and extended a sixth. The University of Illinois is the recipient of a fellowship grant for the study of compounds from vegetable sources or of therapeutic agents, to be under the direction of Roger Adams, Department of Chemistry. Similar fellowships in the Departments of Chemistry at the University of Wisconsin, under the direction of S. M. McElvain, and at the University of California at Los Angeles, under the direction of William G. Young and T. A. Geissman, have also been established. Grants were also made to the Department of Pharmacology, Harvard University School of Medicine, where Otto Krayer will study the pharmacological action of certain botanical specimens of South American origin, and to E. M. MacKay and William G. Clark, Research Department, Scripps Metabolic Clinic, La Jolla, California, for the study of vitamin P-like substances and their effect upon animal organisms. A grant to the University of Michigan for the study of the therapeutic value of mixed estrogens from natural sources administered to the intact skin as an inunction, under the direction of E. C. Pliske, has been extended to January 1, 1948.

Meetings

Applications for admission to the Statistical Summer Session at Virginia Polytechnic Institute, August 5–September 5 (*Science*, May 16, p. 519), have been received from individuals in 26 states from New York to California, and Minnesota to Louisiana, and now number well over 100, according to Boyd Harshbarger, statistician at the Institute and chairman of the Session.

Prof. Harshbarger lists the tentative dates of attendance for outstanding statisticians, some of whom will be in Blacksburg for only a few days. Maurice G. Kendall, Royal Statistical Society, United Kingdom, has indicated he will be in Blacksburg the week of August 25, and Maurice Hansen, probably for the week of August 18. Daniel B. DeLury, until recently a statistician at V.P.I., and Gertrude Cox, University of North Carolina, are listed as seminar speakers for the statistical session.

Commenting on the widespread interest in the statistics school, Prof. Harshbarger states that the professions represented include people with such titles as wood technologists, meteorologists, sociologists, physicists, psychologists, analysts, experiment station directors, engineers, and biologists, to name only a few. In addition to USDA agencies and public health organizations, he has reservations from individuals associated with photograph companies, aircraft builders, life insurance agencies, weather bureaus, and publishers. Colleges and universities which are sending representatives are scattered throughout the United States.

The American College of Physicians will hold its annual meeting in the Civic Auditorium, San Francisco, April 19–23, 1948. William J. Kerr and Ernest H. Falconer, both of San Francisco, are co-chairmen for local arrangements and the program of clinics and panel discussions. Hugh J. Morgan, president of the College of Physicians, and professor of medicine, Vanderbilt University School of Medicine, is in charge of the program of morning lectures and afternoon general sessions. Secretaries of medical societies are especially asked to note these dates in order to avoid scheduling their own society meetings at this time.

The Executive Committee of the 13th International Congress of Zoology has announced that the Congress will be held in Paris, July 21–27, 1948. M. Caullery, chairman of the Permanent Committee of the Congress, will preside. The 10 sections with their presiding officers will be: General Zoology (M. Vandel); Evolution and Genetics (M. Teissier); Cytology and Protistology (M. Fauré-Frémiet); Comparative and Experimental Embryology (M. Wolff); Vertebrates: Comparative Anatomy (M. Prenant); Systematics and Ecology (M. Bourdelle); Invertebrates, excluding insects (M. Fage); Entomology (M. Jeannel); Applied Zoology and Parasitology (M. Vayssière); Zoogeography and Paleontology (M. Arambourg); and Nomenclature (M. Fischer-Piette). Correspondence relative to the Congress should be directed to the Secretary General, M. Fischer-Piette, 55 rue de Buffon, Paris, France.

In spite of efforts of the Executive Committee, it was not possible to arrange for the Congress to be held either just before or just after the two Congresses to be held in Stockholm (Genetics and Entomology), and the dates have therefore been set between the two.

A circular containing material on the Congress is being sent to academies, universities, museums, and societies. If any organization or institution does not receive a copy, the Secretary General should be informed.

The Pittsburgh Conference on X-Ray and Electron Diffraction will be held this year on November 7–8 at the Mellon Institute of Industrial Research, under the sponsorship of local members of ASXRED, the University of Pittsburgh and the Institute. A program for the meetings is now being planned. The program chairman, Earl Gulbransen, has appointed William Kirkpatrick to organize a session on interstitial compounds; a session on electron diffraction studies at high temperatures will be organized by J. Hickman. Two other sessions will consist of

contributed papers of not more than 30 minutes each. Information and suggestions concerning the Conference should be directed to Harold Klug, Mellon Institute of Industrial Research, 4400 Fifth Avenue, Pittsburgh, while titles and abstracts of papers to be presented should be sent to Earl A. Gulbransen, Westinghouse Research Laboratories, East Pittsburgh. Titles should be submitted on or before September 1; short abstracts, on or before October 1.

The Yearbook of Agriculture 1943–1947, entitled *Science in farming*, which has been prepared in the U. S. Department of Agriculture, is currently being distributed. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The price is $2.00. This new book, which contains 1,094 pages and includes 135 reports and 136 pages of illustrations, embraces research on the breeding and feeding of livestock, animal diseases, poultry, genetics, plant growth, vegetables, field crops, plant diseases, trees and farm forestry, fertilizers, conservation, insecticides, and a wide variety of other relevant topics.

The 75th anniversary of the founding of the Anderson School of Natural History on Penikese Island is to be commemorated this year at the Marine Biological Laboratory, Woods Hole, Massachusetts, both by a biological survey of Penikese Island and by an exhibition of Agassiziana in the Library of the Laboratory.

The survey of the westernmost of the Elizabeth Islands will be undertaken on Sunday, August 3, by interested workers from the Woods Hole Oceanographic Institution, the Woods Hole Laboratory of the U. S. Fish and Wildlife Service, the Marine Biological Laboratory, and others who have been invited. Participants will be divided into botanical, ecological, and zoological groups which will be under the direction of John S. Rankin, Jr., of the University of Connecticut, and Donald J. Zinn, of the Marine Biological Laboratory.

The exhibit, during the week of August 10, will consist primarily of letters, manuscripts, papers, and books of Louis Agassiz, former director of the Museum of Comparative Zoology, Harvard University. Various individuals and institutions are lending valuable items for the occasion. Alfred S. Romer, present director of the Museum at Harvard, and others have been invited to speak during the week of the exhibit.

Sir Isaac Newton's Correspondence

The Royal Society of London reached another climax in its long and distinguished history with the outstanding tercentenary celebration, during July 1946 in London and Cambridge, of the birth of its noblest member and president, Sir Isaac Newton. The complete record of the commemoration will be preserved as a valuable and definite contribution to the whole history and philosophy of science. This commemoration will be remembered not alone for the great assembly of distinguished scholars from the world over, but also for the opportunity for a revaluation of Newton's works in terms of today's accomplishments. The respect for Newton's memory shown by such a cosmopolitan group of 148 delegates from almost all of Europe, Asia, South Africa, USSR, South America, and the United States—and even Germany (the venerable 88-year-old Max Planck representing, presumably, no country)—is long to be remembered.

The Royal Society now has in view an even greater and longer-lasting commemoration, namely, the publication of the complete collection of Isaac Newton's correspondence and the replies thereto. The announcement of this undertaking was first made in *The Times* (London, April 25, 1947) by E. N. da C. Andrade, F.R.S., professor of physics in the University of London:

"Although Isaac Newton is acclaimed as the greatest leader of scientific thought that the world has known, there exists no satisfactory collected edition of his work, for that in five volumes which Horsley issued from 1779 to 1785 under the title *Opera Quae Exstant Omnia*, is woefully incomplete. The difficulties in the way of producing a definitive collected edition are many and considerable, one of them being the great mass of unpublished papers which would have to be sifted by scholars of expert experience before those of significance could be extracted and put in order. The task is not likely to be achieved in the immediate future.

"The Council of the Royal Society has decided, however, to make a first step in the direction of producing a worthy edition of Newton's works by publishing the letters which Newton wrote and the replies to them. Some of these letters have been already published in, for instance, the two volumes of correspondence of scientific men of the seventeenth century edited by S. J. Rigaud, but a larger number, including many in the possession of the Royal Society, exist only in manuscript.

"The Council of the Royal Society has entrusted the immediate organization of the matter to a Subcommittee of the Society. It is as chairman of this Subcommittee that I request, with all courtesy, owners of letters to and from Newton to be kind enough to notify the Assistant Secretary of the Royal Society, Burlington House, as to what they possess, in order that, with their permission and cooperation, arrangements may be made either for the temporary loan of the pieces in question or for the supply of photographs. Curators of libraries, museums, and collections are also asked to cooperate in this matter."

It is both appropriate and fortunate that the Council has placed in charge of this undertaking two of its well-known members and Newtonian scholars: H. W. Turnbull, F.R.S., Regis professor of mathematics, United College, University of St. Andrews, as general editor, and Prof. Andrade as chairman of the Subcommittee

It is self-evident that a comprehensive and critical edition of Newton's correspondence is the first desideratum before a complete, national, collected edition of all of Newton's writing can be attempted and, in fact, also before a new life story of Newton can be written. His letters must *all* be available. There are two partially collected volumes of letters, Edleston's *Correspondence of Sir I. Newton and Prof. Cotes*, including letters from other eminent men, from the originals in Trinity College (Cambridge, 1850), and Rigaud's *Correspondence of scientific men of the XVII century*, including letters of Barrow, Flamsteed, Wallis, etc. (Oxford, 1841). Many other sources contain letters, such as Brewster's *Life of Newton* (1855) and More's *Life of Newton* (1934). In addition, there are collected works of Huygens and Leibnitz. The largest collections of Newton's letters are in the libraries of the Royal Society, Cambridge University, Trinity College, Kings College, Christ's College, Oxford, and the British Museum. There are also such private collections as

the Macclesfield. Of late, a number of Newton letters have come on the open market from the Viscount Lymington Library, recently dispersed by Sotheby, London. These were quickly disposed of. It is the letters that have been dispersed for which search must be made.

A more interesting and historically important publication could not be anticipated, for Newton's correspondence covered a period of nearly 60 years and was, in fact, enormous for a single individual of his period. The greatest array of late 17th-century and early 18th-century names in the history of science are among Newton's correspondents, e.g. Isaac Barrow, Richard Bently, Joh. Bernouilli, Robert Boyle, J. Collins, Roger Cotes, John Flamsteed, B. de Foutenelle, James Gregory, Edmund Halley, Robert Hooke, C. Huygens, John Keill, G. W. Leibnitz, John Locke, C. MacLauren, Henry Pemberton, Samuel Pepys, Abbé Varignon, John Wallis, and Christopher Wren. It is doubtful if there ever was a single individual in the history of science who had so large and distinguished a list of correspondents. It was natural that this should be so, because Newton laid the foundation in three important fields: modern mathematics, optics, and dynamics. It is not known that Newton was interested in music; however, in the Portsmouth Collection are several manuscripts bearing upon the theory of music as related to sound, but no correspondence seems to be known in connection with this. As Fellow of Trinity College, Member of Parliament, Director of the Mint, and President of the Royal Society with the longest term known, his correspondence concerned all sorts of phases of science and was with all sorts of individuals. These letters will undoubtedly reveal unknown history of both Newton the man and the scientific spirit of his time. Each of his biographers, from Brewster, his first, to More, his last, has selected and read only a fraction of these letters for his particular need.

As an example of the need of a collected edition of Newton's letters, a more valuable and significant group of letters could never be found in the history of mathematics and astronomy than the correspondence between Newton and Halley relating to the preparation of the *Principia* during the period between 1686 and 1687, and between Newton and Cotes during the preparation of the second edition in 1713. The letters exchanged by Newton and Pemberton relating to the editing of the third edition, and the correspondence between Newton and Flamsteed, Newton and Oldenburg, and Newton and Huygens, are also of the greatest importance and interest.

The increasingly keen interest in Newton and his influence through the ages has been demonstrated quite abundantly, particularly in the past 50 years, through the literature from philosophic and scientific journals. Further and larger commentaries have been published in book form, including a number of recent biographies in English, German, and Spanish. There have also appeared two reprinted editions of the *Principia* and *Optics*, both in the United States and Russia. The publication of Newton's correspondence will stimulate further research.

The next desideratum in the agenda of Newton's revaluation is a more comprehensive and complete bibliography brought up to date. Here again, commemoration of Newton's death (Bicentenary, 1927) and birth (Tercentenary, 1942, but commemorated in 1946), a great celebration by the Academy of Sciences of the USSR in 1942, and the commemoration of the 250th anniversary of the publication of the *Principia* have produced several hundred new titles in books and periodical literature. A record of all this literature would seem to be imperative. Each of the two bibliographies now in print (Gray's, 1907 and Zeitlinger's, 1927) is limited; the first contains 412 titles, and the latter is a critical annotated list of Newton's own publications. The undersigned hopes to complete within one year a new bibliography of Newton which now comprises more than 2,000 titles. It is intended to extend this bibliography to include all titles (as, for instance, Celestial Mechanics) having a direct bearing upon Newton's laws.

Clearly, before the greater project which the Royal Society has in view can be undertaken, it is necessary that all of Newton's letters be made available and in print. Likewise, a critical annotated bibliography of Newton's writings and commentaries should be encouraged for the identical purpose, since both projects would aid the editors of the national edition to secure further critical and historical data.

Newton's influence in America began early in the cultural progress of the colonies. Scholars and teachers at Harvard College, Yale College, and the College of William and Mary (Cotton Mather, John Winthrop, David Rittenhouse, James Logan, James Madison, and many others) helped greatly to establish our first definite scientific epoch in the colony. Newton's first correspondent in the colonies was Arthur Storer, of Patuxent River, Maryland. Storer sent Newton fairly respectable observations of the comet of 1680. Thomas Brattle, of Harvard College, sent similar notes to Flamsteed, the first Astronomer Royal at Greenwich. Both sets of observations were used by Newton and Halley to facilitate the determination of the first complete set of orbital elements of a comet and thereby established the law of gravitation as related to celestial bodies and made possible the beginning of the *Principia*.

The Royal Society desires to advise those collectors and scholars, as well as libraries, here in America who are in possession of letters written by Newton and replies to him that it would greatly appreciate their cooperation in the loan of the letters or a photographic copy of them. The undersigned, who is a member of the Subcommittee representing the Royal Society in this project, would therefore be grateful for notification of the whereabouts of these letters in order to facilitate their transmission to the editors of the proposed work. (FREDERICK E. BRASCH, *Honorary Consultant in the History of Science, Library of Congress, Washington, D. C.*)

Make Plans for—

American Veterinary Medical Association, August 18–21, Cincinnati, Ohio.

New England Association of Chemistry Teachers, 9th Summer Conference, August 18–23, Wellesley College, Wellesley, Massachusetts.

American Pharmaceutical Association, August 24, Milwaukee, Wisconsin.

American Society of Mammalogists, August 24–27, Higgins Lake, Michigan.

American Institute of Electrical Engineers, Pacific General Meeting, August 26–29, San Diego, California.

American Association for the Advancement of Science, 114th Meeting, December 26–31, Chicago, Illinois.

TECHNICAL PAPERS

Preparation of Formaldehyde-inactivated Poliomyelitis Virus and Its Use as an Immunizing Agent in Cotton Rats[1]

HUBERT S. LORING, C. E. SCHWERDT, NANCY LAWRENCE, and JANE COLLIER ANDERSON

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The inactivation of relatively crude preparations of poliomyelitis virus by formaldehyde treatment and by ultraviolet irradiation has resulted in samples capable of producing a significant immunity against an intracerebral challenge of active virus. The extent to which such immunity has depended on the presence of humoral antibodies or of virus-resistant nervous tissue is not known, but the presence of neutralizing antibodies in the blood after immunization has been demonstrated (*1*). The vaccines used in such experiments have consisted of extracts of finely-ground brain and spinal cord of infected monkeys or mice and contained relatively small quantities of virus and large quantities of normal tissue components.

The use of such crude vaccines is objectionable for several reasons. It is likely that higher concentrations of formaldehyde would be required to produce complete inactivation because of the protective colloid action of the normal proteins on virus and because of competitive reactions between the two for formaldehyde. As formaldehyde concentration is increased, it is also likely that not only virus activity but antigenicity would be lost. A further objection to the use of crude preparations is the large mass of tissue proteins which must be injected in order to provide a sufficient quantity of inactive virus to stimulate an appreciable antibody response. If an inactive-virus antigen free from the normal tissue components were available, it is possible that a much greater response could be elicited and a higher degree of immunity achieved.

The development of a method of preparation of concentrated Lansing virus in moderate quantities (*2*) has made possible the study of the inactivation of virus relatively free from normal tissue constituents and the use of such a material for immunization against active virus. Lansing virus produced in cotton rats and purified by two cycles of differential ultracentrifugation was treated with formaldehyde in concentrations from 0.02 to 0.1 per cent by volume. The concentration of virus used varied from 3×10^{-4} to 4×10^{-4} grams of nitrogen/ml. The mixture of virus and formaldehyde in M/15 phosphate buffer at pH 7 was stored in the refrigerator and its infectivity in comparison with the original untreated virus determined after different time intervals. Infectivity of each preparation was measured by the intracerebral injection of six 10-fold dilutions in six groups of five young cotton rats each. A volume of 0.05 ml. was used for each animal, and the specific infectivity was calculated as the 50 per cent infective dose, or ID_{50} in grams of virus nitrogen/ml. (*2, 3*). The results of five experiments with three different formaldehyde concentrations are shown in Table 1.

The results show that at refrigerator temperatures the Lansing virus is completely inactivated by formaldehyde

TABLE 1

ACTIVITIES OF ORIGINAL VIRUS AND OF VIRUS FORMALDEHYDE MIXTURES AFTER STANDING IN REFRIGERATOR FOR VARYING LENGTHS OF TIME

Expt. No.	Concentration of formaldehyde (%)	Specific activity as grams nitrogen/ml.* after: 4 days		12 days		50 days
		Original virus	Treated virus	Original virus	Treated virus	Treated virus
86	0.02	$10^{-9.7}$	$10^{-8.7}$	$10^{-9.0}$	$10^{-4.0}$	
88	0.05	$10^{-8.9}$	$10^{-7.1}$			
89–90	0.05			$10^{-9.7}$	$10^{-7.0}$	
87	0.10	$10^{-8.3}$	Completely inactive at $10^{-3.7}$			
91-2-4	0.10			$10^{-11.7}$	$10^{-4.0}$†	Completely inactive at $10^{-3.4}$

* Calculated by the method of Reed and Muench (*3*).

† At the highest concentration used, $10^{-3.7}$ grams nitrogen/ml., two out of three rats developed poliomyelitis. No animals showed positive signs at lower concentrations.

only when a concentration of 0.1 per cent is used and the virus and formaldehyde mixtures are allowed to stand for somewhat longer than 12 days. After four days of contact with 0.1 per cent formaldehyde, one treated virus sample was completely inactive, and after 12 days another showed only a trace of activity (less than 0.0002 of one per cent). In the latter experiment no activity could be detected when the mixture had stood for an additional 38 days. In contrast to concentrated influenza virus, the Lansing virus shows an appreciably greater resistance to inactivation by formaldehyde (*4*), a result in agreement with its recognized greater stability.

In the early experiments on the ability of the formaldehyde-inactivated virus to immunize cotton rats, the intraperitoneal route of injection was used. In one such experiment, in which 32 young cotton rats were immunized by two intraperitoneal injections containing a total of 3×10^{-6} grams of completely inactive virus nitrogen (Experiment 87, 0.1 per cent formaldehyde after 4 days), 18 per cent of the test animals survived a challenge of 100 ID_{50} doses given four days after the last injection. When 9 control animals were challenged with the same dose of virus, 1 was found dead after four days without previously recognized signs of the disease and 8 developed typical poliomyelitis.

More significant results were found when the rats were im-

[1] Aided by a grant from the National Foundation for Infantile Paralysis, New York City.

munized by three injections given at weekly intervals by a combination of the intradermal, intramuscular, and subcutaneous routes. A total of 10^{-5} grams of formalized virus nitrogen (Experiment 91-2-4 after 12 days) was administered to each of 30 rats in three doses as follows: $10^{-5.6}$ grams of nitrogen intradermally, $10^{-5.3}$ grams of nitrogen intramuscularly a week later, and $10^{-5.6}$ grams of nitrogen subcutaneously at the end of another week. A similar group of animals was immunized by the same method with 10^{-5} grams of nitrogen of the same vaccine in a petroleum oil suspension.

The degree of immunity present in the two groups was estimated by finding the titer of active virus in each in comparison with that of normal control animals of the same age. Concentrations of virus were prepared in steps of 10 from 2×10^{-10} to 2×10^{-5} grams of nitrogen/ml. Each concentration was then injected intracerebrally in a volume of 0.05 ml. into each of five animals from the two immunized groups one week after the last vaccine injection. The control animals were tested similarly with concentrations of virus ranging from 2×10^{-12} to 2×10^{-7} grams of nitrogen/ml. The titer of virus used was calculated from the control animals and, expressed as the ID_{50} dose, was found to be $10^{-11.7}$ grams of nitrogen/ml. Similar titers calculated for the two immune groups were $10^{-6.2}$ for the first mentioned and $10^{-6.5}$ for the group injected with vaccine in oil emulsion.

It is evident from these titers that over 300,000 times as much virus was required to infect 50 per cent of the first group of vaccinated animals as was found necessary for the normal controls. Similarly, in the second group, 150,000 times as much virus was required.

The survivors from both groups were pooled and rechallenged by the same method 10½ weeks after the first challenge. The titer found with the immunized animals as compared with that of their normal controls showed that about 500 times as much virus was now required to infect 50 per cent of the immunized group.

It is possible that the high degree of immunity produced in the experiment cited above was due to the presence of the trace of active virus found in this preparation. Further immunization experiments with the vaccine which showed no virus activity were carried out to test this question. Twenty-four rats immunized with the same amount of completely inactive vaccine by the three routes previously used were each challenged intracerebrally one week after the last injection with about 1,000 ID_{50} doses of active virus. One of the group developed paralysis but recovered, while the remaining 23 showed no signs of the disease. In a similar number of normal control animals receiving the same dose of virus 83 per cent developed poliomyelitis. It is likely, therefore, that the extent of immunity produced by the vaccine after 12 days of exposure to formaldehyde was due to the inactive virus rather than to the traces of activity present.

The 24 survivors from the last-mentioned experiment were rechallenged with 10,000 ID_{50} doses of virus three weeks after the first challenge. A high degree of immunity was still present, as shown by the fact that 67 per cent of the animals survived without showing signs of poliomyelitis as compared to 92 per cent of a similar group of normal controls which developed the disease when injected with the same amount of virus.

The results presented show that cocenntrated Lansing virus from cotton rats can be completely inactivated by formaldehyde and that such inactive virus can be used to produce a high degree of immunity toward the homologous virus. The data show that infectivity as such is not a prerequisite for a vaccine which, in amounts of 10^{-5} grams of concentrated virus nitrogen, produces a highly significant protection against the intracerebral injection of active virus. Whether protection is obtained by neutralization of virus at the site of injection by humoral antibodies or by some other mechanism is not known. The presence of neutralizing antibodies in high titers in the blood of the immunized rats has been demonstrated both by neutralization tests and by the complement fixation test. These results will be presented in an early publication.

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Filaricidal Activity of Substituted Phenyl Arsenoxides[1]

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In the treatment of both canine and human filariasis antimony-containing compounds have been used to the exclusion of almost all other types of therapy. Accordingly, early in our search for an improved form of therapy considerable attention was given to new or hitherto unexplored antimony compounds. The results were disappointing in that we failed to obtain evidence that antimony in therapeutically feasible doses would ever regularly kill the adult filaria, *Litomosoides carinii*, of cotton rats or *Dirofilaria immitis* of dogs. We therefore intensified our search for an entirely different type of therapeutic agent. Consideration was given to the possible advantages of nonmetallic compounds, but in so far as our investigations were carried no such compound was found which appeared to offer any advantages over the antimonials.[3] However, preliminary screening revealed that Mapharsen had an *in vitro* microfilaricidal activity far greater than anything hitherto reported. This led to a study not only of Mapharsen itself but of the whole group of available substituted phenyl arsenoxides.

The attempt to use arsenic in the treatment of filariasis is not new. Among the more recent advocates of its possible value in the therapy of filariasis are King (*4*) and Van der Sar and Hartz (*8*), who obtained evidence of clinical improvement without destruction of the microfilaria following the use of

[1] This work was carried on initially under a contract recommended by the Committee on Medical Research between the Office of Scientific Research and Development and The Johns Hopkins University; it was continued under a contract between the Office of the Surgeon General, U.S.A., and the same university.

[2] Now in the Department of Pharmacology and Experimental Therapeutics, School of Medicine, The Johns Hopkins University.

[3] Welch, *et al.* (*9*) have since reported favorable results with cyanines in laboratory animals.

Mapharsen. It is of interest that in Hawking's study (*3*) of the *in vitro* killing of microfilaria of *Wuchereria bancrofti*, 6 of the 7 trivalent arsenicals killed the microfilaria at greater dilution than did any of the 28 other compounds used, including two antimonials (tartar emetic and fuadin). Apparently Goodman and Gilman's statement (*2*) that "micro-filaria can be killed by organic arsenicals" results from Hawking's report, although that worker and Chopra and Rao (*1*) were unable to obtain evidence of *in vivo* killing of microfilaria by these arsenicals.

We have conducted both *in vitro* and *in vivo* studies on the effect of various compounds on microfilaria and adult filaria as well as a study of the toxicity, absorption, and excretion of those offering promise of therapeutic value. However, discussion will be confined here to the filaricidal activity of the substituted phenyl arsenoxides with particular reference to p-[bis-(carboxymethylmercapto)-arsino]-benzamide (Tropical Disease Center #970).

The group of phenyl arsenoxides was shown to have an *in vitro* activity against the microfilaria of *D. immitis* 10–300 times that of the most active of the antimony compounds tested. Thus, within the group of phenyl arsenoxides there was approximately a 30-fold difference between the least active and the most active, whereas there was scarcely more than a 3-fold difference in the acute toxicities for mice. The amide substituted compounds, such as those with the p-$CONR_2$ or p-$SONR_2$ substitution, killed the microfilaria at the highest dilutions. Despite previous reports of the failure of Mapharsen to reduce the microfilaria blood levels in man, this seemed to warrant further study. Accordingly, it was administered to cotton rats infected with *L. carinii* in doses of 0.9 mg. As (3.0 mg. Mapharsen)/kg. b.i.d. intraperitoneally for 45 days and to a dog, infected with *D. immitis*, in doses of 0.6 mg. As (2.0 mg. Mapharsen)/kg. intravenously daily for 35 days. The results were completely negative.

Six other phenyl arsenoxides, kindly supplied by Harry Eagle, of the U. S. Public Health Service, were administered intraperitoneally to cotton rats in doses of 0.9 mg. As/kg. b.i.d. for 25 and 45 days. All showed some activity, and all four of the amide substituted compounds reduced the microfilaria blood levels 70–90 per cent during the course of treatment; three of them killed 90–100 per cent of the adult worms. Only p-arsenosobenzamide (OAs  $CONH_2$), among these compounds, killed all the adult worms in half the above daily dose (0.45 mg. As/kg. b.i.d.) for the same length of time and reduced the microfilaria blood level 50–80 per cent. In lower doses and for shorter periods of time there was some lethal action upon the adult worms but little or no reduction in the microfilaria level. In dogs with daily intravenous doses of 0.45 mg. As/kg. it failed to produce any reduction in the microfilaria count, but in each of the two animals killed at the end of treatment 6 dead, but no living, worms were found in the pulmonary arteries. The microfilaria blood level of the remaining dog was followed for one year and dropped in that time to about one-fifth of its pretreatment level, while the microfilaria count actually rose in the untreated animal. When the animal was necropsied, one living adult was found in the heart. Since this compound is so insoluble (about 1:800 in water), work with it was discontinued and consideration given to the synthesis of a more soluble analogue.

A number of compounds were studied in which organic radicals were substituted for oxygen in the p-arsenosobenzamide. The dithioglycollate substituted compound which was made in our laboratory (*5*)[4] seemed to offer promise of both solubility (2 per cent solutions are practical) and a favorable therapeutic index. This compound, p-[bis-(carboxymethylmercapto)-arsino]-benzamide, killed all the adult worms in cotton rats receiving 0.9 mg. As (4.5 mg. drug)/kg. b.i.d. intraperitoneally for 6 weeks but failed to effect any reduction in the microfilaria level; various shorter courses of treatments

TABLE 1

TREATMENT OF *Dirofilaria immitis* WITH DAILY INJECTIONS OF #970

Dog	Daily dose (mg. As/kg.)	No. of injections	Total dose (mg. As/kg.)	Fate of dog	Adult worms	
					Alive in heart	Dead in pulmonary artery
11	1.8	5	9	D, 5 days	33 (Sluggish)	5
25	1.8	3	5.4	" "	0	3
5	0.9	30	27	Healthy, K	0	11 ♀ 11 fr.†
27	0.9	30	27	" "	0	2 fr.
28	0.9	15	13.5	" "	0	7 ♂ 2 ♂ 2 fr.
9	0.9	15 (alternate days)	13.5	" "	1 ♀ (Sluggish)	0
29	0.45	15	6.8	" "	0	3 ♀ 2 fr.
32	0.23	15	3.4	" "	0	4 ♀ 6 ♂ 2 fr.
31	0.23	11	2.5	D,* 12 days	0	19 ♀ 12 ♂
34	0.115	15	1.7	Healthy, K	2 ♀ 1 ♂ (active)	0

* This dog was critically ill before experiment started.
† fr. = fragmented.

killed some of the adult worms. The administration of the drug intravenously to dogs infected with *D. immitis* likewise failed to reduce the microfilaria level during the course of treatment. On the other hand, the drug seems to be consistently effective against the adult worms in daily doses of 0.23 mg. As (1.15 mg. drug)/kg. or more for two weeks or longer. It appears also that effectiveness of the drug may not be measured in terms of the total dose alone, since a total of 9.0 mg. As/kg. given in 5 daily doses of 1.8 mg. As/kg. (dog 11) and 13.5 mg. As/kg. given as 0.9 mg. As/kg. every other day (dog 9) did not kill all the adult worms, whereas smaller total doses, 3.4 mg. and 6.8 mg. As/kg. (dogs 32 and 29), given in doses of 0.23 and

[4] We are indebted to C. K. Banks, of Parke, Davis & Company, Detroit, who later supplied the main stock and its precursor (#622) from which we made much of our supply, and to Fitzgerald Dunning and J. H. Brewer, of Hynson, Westcott, and Dunning, Baltimore, who ampouled the compound in 2 per cent solution for use.

.5 mg. As/kg. daily for 15 days were effective (Table 1). The comparative series is admittedly small, but it is supported by similar experience with the same drug in cotton rats infected with *L. carinii*. More work is needed to determine whether or not the effective dose is lower than 0.23 mg. As (.15 mg. drug)/kg. daily for 15 days or even to state with certainty that this dose would always be effective. However, 0.23 mg. As/kg. doses of this drug for 15 days appear to be feasible for man. Thus, for the first time, so far as we know, a chemical compound has been shown to kill all the adults of *D. immitis* in doses which appear to be feasible for man.

As pointed out in our brief summaries (*6*, *7*), this compound has approximately the same toxicity for laboratory animals as Mapharsen; it is tolerated by monkeys in doses of 0.9 mg. As/kg. for 20 days. It contains 20 per cent arsenic and is stable either as a powder or as a 2 per cent solution (*5*). Studies are accordingly now in progress to determine its possible value when used against both canine and human filariasis under conditions of routine practice with these infections.

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The Development of Visual Perception in Man and Chimpanzee

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The study of innate visual organization in man is not open to direct observation during early infancy, since a young baby is too helpless to respond differentially to visual excitation. A first attack on this problem has been made by investigating the visual responsiveness of persons born blind and later made able to see by cataract removal. To evaluate the apparent contradictions between these clinical reports and experimental findings with lower mammals and birds, chimpanzees were reared in darkness until sufficiently mature for the testing of visual responsiveness. The results, which corroborate and extend data reported for man by Senden (*3*), may require changes in current theories of learning and perception.

Two chimpanzees were reared in darkness to the age of 16 months.[1] The animals were then brought periodically into the light for a regularly repeated series of observations. By the time of the first observations the animals had developed postural and locomotor skills roughly comparable to normally reared chimpanzees of the same age or approximating in a general way those of a two-year-old human child. At this time the total light experience, received in half a dozen brief (45-second) episodes daily, as required by the routine care of the animals, was approximately 40 hours. At 21 months of age the female was brought permanently into normal indoor illumination. At the present writing the animals are 26 months of age. A full account of their behavior will appear in future publications.

The first tests of visual reactions with both subjects demonstrated the presence of good pupillary responses to changes in light intensity, pronounced startle reactions to sudden increases of illumination, and a turning of the eyes and head toward sources of light. In the darkroom there was pursuit of a moving light with both eye and head movements. The eyes, however, did not fixate steadily on a light. During all tests episodes of a resilient "spontaneous" nystagmus occurred, the quick phase usually toward, and the slow phase away from, the light source. With the subject sitting stationary at the center of a rotating drum marked in alternating black and white stripes, tests for optokinetic responses were made. Characteristic pursuit eye movements with quick jerks in the opposite direction were obtained.

Aside from the reflexes just described, and the pursuit of a moving light, the two animals were, in effect, blind. The acquisition of visually mediated responses proceeded very gradually, with no evidence of any sudden increased responsiveness such as might be expected if, for example, the failure to respond was at first due to a general lack of attention to visual stimulation. No fixation of any object, still or moving, could be elicited in any of the early tests. For a long time there was no eye blink when an object was brought rapidly toward the eyes. An object brought slowly toward the face produced no response until contact was made, when the animal reacted with a quick jerk in the typical startle pattern. With the female this was observed for the last time on the 30th day after she was moved into the daylight room. Her first blink to a threatened blow in the face occurred on the 5th day, but occurred consistently only after 48 days, at which time she had been in the light for a total of 570 hours, was 22½ months old, and had for a month received some pushing around daily in short play periods with a younger but visually sophisticated chimpanzee.

Many repetitions of experience with objects presented visually were necessary before any recognition of such objects appeared in either subject. The feeding bottle, for example, was thoroughly familiar tactually and kinesthetically. If the bottle or nipple touched the hand, arm, or face, either animal promptly seized the nipple in its mouth. First signs of *visual* recognition occurred in the female when she protruded her lips toward the bottle on the 33rd meal, or the 11th day, following her shift into the daylight room. The first reaching for the bottle with the hand (done before 12 months of age by normally reared animals) appeared on the 48th meal, or 16th day in the light. With the male, whose visual experience was limited to mealtime, many more feedings were required before these responses appeared. The first reaching responses of both animals were grossly inaccurate.

A training procedure employing electric shock showed that the learning of avoidance responses was also an extremely slow and gradual process.

These results can best be interpreted in conjunction with the data of Senden. Lacunae in each set of findings, clinical and experimental, are in many respects filled by the other.

[1] The early rearing in the darkroom was arranged by H. G. Birch, whose part in this experiment is gratefully acknowledged.

In the first place, there is no question that the chimpanzee subjects were well motivated. Sufficient hunger to produce whimpering, and shock severe enough to bring vocal protests, did not alter the fact of failure to "see." The similar slowness of learning of the human patients therefore cannot be accounted for merely by a defect of motivation. The emotional disturbances would seem to have been the result of slow learning, just as Senden concluded, rather than its cause; that is to say, the patient lost some of his enthusiasm when he found how difficult it was to make effective use of the new and at first interesting sensations.

Secon ly, the verbal assistance given the human patients make it clear that the difficulty is not simply a failure to attend to visual sensations. With attention successfully directed to a newly-introduced stimulation, as attested to by the patient's partial success in describing it, learning to identify remained a tediously slow process, with the notable exception of color naming. Since color names were learned easily, it cannot be said that "visual attention" was absent.

The prompt visual learning so characteristic of the normal adult primate is thus not an innate capacity, independent of visual experience, but requires a long apprenticeship in the use of the eyes. At lower phylogenetic levels the period of apprenticeship is much shorter. The chick makes effective use of vision immediately upon hatching and shows further improvement of efficiency with the practice afforded by a dozen pec (*1*). Rats reared in darkness, when first exposed to light, sho no clear utilization of vision but learn to jump in response t visual cues within 15 minutes and after an hour or two may b indistinguishable from the normally reared animal (*2*). Th chimpanzees of the present study received 50 hours of exposur before the first visually mediated learning was evident; an man, to judge by some of Senden's cases, may require an eve longer exposure.

The comparative data conform to the generally recognize principle that organisms whose potential adaptations to th environment are most complex, *i.e.* those that show the greatest intelligence at maturity, also require the longest perio of development. This has generally been regarded as a perio of maturation. The clinical and experimental data discusse here, however, show that this long period is also essential fo the organization of perceptual processes through learning.

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IN THE LABORATORY

Intestinal Perfusion in the Treatment of Uremia

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Interest in the removal of nonprotein nitrogenous constituents of the blood by "artificial" means in cases of renal failure has been stimulated greatly by the recent work of Kolff (*1*), Fine and his associates (*3*), Murray (*2*), and others. It has been suggested (*1*) that perfusion of a loop of bowel, isolated surgically, might prove superior in some respects to other methods presently used. It occurred to one of us (J. W. R.) that a specially designed intestinal tube with three lumina might make it possible to perfuse the intestine *in situ*, thus rendering surgical intervention unnecessary. Furthermore, aseptic technique would not be required.

By using a thin, triple-bore rubber tube, with a small balloon on the tip, it has been possible experimentally to perfuse any desired length of intestine without resorting to surgery of the bowel. However, in the dog it is necessary to manipulate the tube into position through an abdominal incision. This would be unnecessary in the human. Warmed perfusion fluid of physiological type has been introduced above the inflated balloon and withdrawn through another lumen of the same tube several feet higher up.

In experiments to date the blood nonprotein nitrogen of nephrectomized dogs has been reduced consistently and materially. For example, a lowering of the azotemia from 198 to 126, 198 to 112, and 231 to 145 mg./100 ml. of blood was observed in successive trials using 12–18 l. of perfusion fluid over a period of about 6 hours. The rinsing fluid after perfusion contained 4.3–5.4 grams of nonprotein nitrogen.

A more detailed experimental study of the method is now in progress and investigation of its clinical application is being undertaken.

[1] Our thanks are due to C. H. Best, of the Department of Medical Research, and to John Mann, of the Department of Obstetrics and Gynaecology, for much appreciated help and stimulation.

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Simple Method for Cross-indexing a Reference File

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In attempting to keep a reference file of current research one soons finds oneself in the perplexing situation of having several hundred cards on hand without an adequate cross-indexing system in operation. If, during the early stages of collecting reference material, one utilizes a multiple-card system, *i.e.* a separate card for each subject under which one particular reference can be filed, the number of cards needed soon makes space a limiting factor.

The ideal system, of course, is that in which only one card per reference is employed and which permits that reference to be selected from the file under any of several different subject headings. This ideal has been achieved in the punch-card system. However, to the average scientific worker this system presents two serious disadvantages: (1) Since special cards are used, the initial cost is fairly high; (2) having obtained these cards, transfer of the references from the original cards to the new ones necessitates an enormous amount of secretarial work.

The present communication describes a method for cross-indexing a file which is already in existence. The chief aims have been to obviate extra secretarial work and to achieve some advantages of the punch-card system.

In essence, the operation for cross-indexing involves notching the reference card along its top or side edges at positions corresponding to each of several different subject headings indicated on a master card.

Compilation of the master card is the most important task, since its design determines the ultimate efficiency of the system. Several features of the design deserve consideration: (1) One must decide at the outset which subject headings are likely to be most useful; the indexing system will do anything required of it, provided the subject headings are properly chosen. (2) The various headings are then divided into two classes, the *general* and the *specific*; *i.e.* for the general heading *Metabolism* there may be the specific headings *carbohydrate*, *fat*, *nitrogen*, *phosphate*, etc. (3) The importance of arranging these headings along the edges of the master card becomes apparent when one realizes that only the top edges of the cards are immediately visible in the file drawer. Since a reference is more commonly sought under a specific rather than a general subject heading, the former are made more readily available by arranging them along the top edge of the master card.

The master card itself is made from an ordinary blank card of the size used in the file, holes 2 mm. in diameter and about 2 mm. apart being punched along each of its top and two side edges. Subject headings are then listed opposite the holes.

In the author's file, general headings such as *Biochemistry*, *Metabolism*, *Enzymology*, *Pharmacodynamics*, are listed along the left-hand margin and specific headings along the top edge. Since it is also useful to know the tissue or organism used in a physiological study, the right-hand margin contains such specific headings as *amphibia*, *yeast*, *liver*, *brain*, etc.

To index a reference, the master card is superimposed over the card containing the reference, pencil marks being made on the latter through the holes in the master card opposite the appropriate headings. The reference card is then notched by punching semicircles opposite the marks. If the master card has been properly designed, each card should have at least one notch on each of its two side edges. (There may not be a notch along the top edge if the subject is of a general nature.)

The notched cards are finally filed alphabetically, by authors, under sections corresponding to the general headings listed on the left-hand margin of the master card.

The availability of data under this system is readily apparent. General information is obtainable at once, since the file is arranged in general sections. As each card in the general section has been punched in the same position along its left-hand margin, the section as a whole now exhibits a groove, along its side. Any card out of place shows up as a break in the groove.

To find a specific reference in a general section, the cards are first brought into alignment by moving them against one side of the drawer. The master card is then held in position in front of the section, or moved horizontally over the section if it is a long one, and the desired cards selected. Subjects listed along the right-hand margin are discovered by removing the section in whole or in part and bringing the cards into alignment both side and bottom; the master card is then used in the same manner to find a specific reference.

By this method it is possible to select one or two specific references out of several hundred cards in a matter of seconds. Furthermore, within a given section (e.g. *Metabolism*) all the references relating to one specific heading (e.g. *phosphate*) may be selected, or within the same section all the references pertaining to a specific tissue may be found with equal ease.

A Culture Medium for the Primary Isolation of Fungi

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Although Sabouraud's dextrose agar is widely employed for the cultivation of fungi, it has many shortcomings, particularly when used for the primary isolation of pathogenic fungi from material containing a mixed flora including bacteria, yeasts, actinomycetes, or saprophytic fungi. Gram-positive and gram-negative bacteria grow luxuriantly and rapidly on the medium, making it difficult to isolate pathogenic fungi from specimens such as feces, sputum, or exudates. Many clinical specimens must be treated with 70 per cent alcohol or other agents to destroy surface bacteria if dermatophytes are to be successfully isolated on Sabouraud agar. The acid reaction of the medium may prevent or retard the development of those pathogenic fungi for which the optimum pH is in the neutral or alkaline range. Furthermore, the utility of Sabouraud agar is seriously hindered by the rapid spreading growth of saprophytic fungi, which are invariably present in pathological specimens and in laboratory air. Since most pathogenic fungi grow more slowly than saprophytic species, they are isolated with difficulty in many cases or not at all in others. A new medium for the primary isolation of fungi was therefore thought to be very much needed. Studies were commenced along three separate lines of endeavor with that specific aim in mind.

The problem of restricting the spreading of fungi on agar media was first examined. After many different formulas had been tested, the following was found to support growth of 34 strains of pathogenic and saprophytic fungi in our collection as small, but well myceliated, discrete, *nonspreading* colonies at a rate comparable to that of Sabouraud agar: 1 per cent dextrose, 1 per cent granular peptone, 1.5 per cent dehydrated oxgall, and 2 per cent agar in water (no pH adjustment required).[1]

It was at first erroneously believed that oxgall in the concentration used above would inhibit gram-positive bacteria, particularly staphylococci. When this was proven not to be the case, other antibacterial agents known to be active against gram-positive bacteria were studied with a view to their incorporation into the medium. After a number of trials with different compounds, crystal violet[2] in final dilution of 1/100,000 was found to inhibit staphylococci and other gram-positive bacteria but not to hinder the growth of 34 known species of saprophytic and pathogenic molds, yeasts, and actinomycetes, as well as numerous strains of fungi isolated from laboratory air.

TABLE 1

FUNGI CAPABLE OF GROWING ON OXGALL-CRYSTAL VIOLET AGAR CONTAINING 30 UNITS OF STREPTOMYCIN/CC.

Pathogenic species	
*Blastomyces dermatitidis**	*Microsporum audouini*
" *brasiliensis*	" *canis*
Coccidioides immitis	" *gypseum*
Histoplasma capsulatum	*Trichophyton Schoenleinii*
Sporotrichum schenkii	" *violaceum*
Hormodendrum Pedrosoi	" *rubrum*
" *compactum*	" *mentagrophytes*
Phialophora verrucosa	" *sulfureum*
Cryptococcus neoformans	*Epidermophyton floccosum*
Candida albicans	*Monosporium apiospermum*
Torula (Elton)†	*Geotrichum* sp.
Nonpathogenic species	
Rhizopus nigricans (+)	*Candida candida*
" " (−)	*Fusarium*
Aspergillus herbariorum	*Alternaria*
Penicillium expansum	*Cladosporium*
" *notatum*	*Mucor mucedo*
Neurospora sitophila	*Scopulariopsis brevicaulis*

* Two strains.
† Isolated from a fatal case of meningitis.

Many chemical agents known to exert selective bacteriostatic activity versus gram-negative bacteria were investigated for addition to the oxgall-crystal violet agar; these included brilliant green, sodium azide and potassium tellurite. In no instance was it found possible to inhibit simultaneously all members of the Enterobacteriaceae family and the *Pseudomonas* genus without retarding or inhibiting some species of pathogenic fungi. Because of the wide range of activity of streptomycin against gram-negative bacteria and an observed high tolerance of one pathogenic fungus, *Blastomyces dermatitidis*, to streptomycin (*1*), this antibiotic was selected for trial. The hope that other species of fungi would show similar tolerance to streptomycin was fulfilled.

Oxgall-crystal violet agar was sterilized at 10–12 pounds pressure for 15 minutes[3] (115–117.7° C.) and then cooled to approximately 46°C. Sufficient streptomycin sulfate[4] in 5 cc. of sterile saline was then added and well mixed, immediately prior to pouring, to provide a final concentration of 30 units of the antibiotic/cc. of agar. All fungi in our collection were unaffected by the concentration of streptomycin used and grew unrestrictedly, with the exception of *Nocardia asteroides* (Table 1). Numerous laboratory aerial fungi, developing at approximately the same rate of growth in the streptomycin-containing oxgall-crystal violet agar as in Sabouraud agar, grew as small, well-isolated, *nonspreading* colonies (Fig. 1).

The degree of inactivation of streptomycin by brief exposure to 46°C. was not measured, but this was assumed to be negligible, since solutions of streptomycin can be heated to 100°C. for 10 minutes with loss of less than 50 per cent (*2*). In order to ascertain the stability of the antibiotic in the medium, streptomycin-containing oxgall-crystal violet agar was incubated at room temperature and 37°C. for varying periods and tested daily with pure cultures of *Escherichia coli* and fecal suspensions. Not only freshly prepared medium but also plates of medium incubated beforehand at both temperatures for a period of several weeks showed continued and undiminished, selective, inhibitory activity toward *E. coli* as well as most of the gram-negative bacteria present in normal and pathological feces. This attested to considerable stability of streptomycin in the poured medium.

A medium containing dextrose, peptone, oxgall, agar, and 30 units of streptomycin/cc. (excluding crystal violet) was streaked heavily with 10 different specimens of sputum. Since it was observed that a considerable number of gram-positive bacteria were able to form colonies on the medium, the presence of crystal violet as well as streptomycin was considered necessary in the formula.

The completed medium, containing, in distilled water, 1 per cent dextrose, 1 per cent peptone, 1.5 per cent oxgall, 2 per cent agar, 1/100,000 crystal violet, and 30 units of streptomycin/cc. of agar was tested in parallel with Sabouraud agar by heavy inoculation with specimens of feces and sputum obtained from the Clinical Diagnostic Laboratory, Charity Hospital, New Orleans. Approximately three times as many colonies of fungi and twice as many different fungal species could be recovered in pure culture from the new medium as from Sabouraud agar. Many specimens producing only a heavy bacterial overgrowth on Sabouraud agar developed 30-100 well-isolated mold and yeast colonies on the new medium (Fig. 2).

When used together in oxgall agar, crystal violet and streptomycin inhibited the growth of both gram-positive and gram-negative bacteria from heavy inocula of feces, sputum, and other grossly contaminated specimens. Molds and yeasts were permitted to grow as nonspreading, well-separated colonies which were easy to isolate in pure culture.

[1] All elements of this formula are Bacto grade, Difco Laboratories, Detroit, Michigan.

[2] Crystal violet (indicator): dye content, 91 per cent; National Aniline Division, 40 Rector Street, New York City. *Stock solution:* 1.25 grams dissolved in 25 cc. of 95 per cent ethyl alcohol and kept in a tightly stoppered bottle. *For use:* 0.2 cc. added/liter of medium.

[3] Heating in excess of this pressure and temperature may cause the formation of an insoluble precipitate on the surface of the agar due to heat instability of the oxgall.

[4] Two commercial brands found satisfactory.

Present studies indicate that the new medium holds considerable promise as a diagnostic tool for the primary isolation of fungi from specimens possessing a mixed bacterial and fungal flora. It might also be employed (1) for an easier estimation of the *normal* fungal flora of feces, sputum, and other human discharges; (2) for a more accurate evaluation of human disorders of the upper and lower respiratory and gastrointestinal tracts caused by fungi; (3) as a simpler method of single-cell isolation of fungi; (4) for an accurate quantitative estimation of viable saprophytic fungi in foodstuffs by plating techniques; (5) for an easier estimation of the fungal flora and content of the air; and (6) as a more rapid and proficient method for the examination of feces and sputum in incipient infections of the civil population with fungal agents of disease. These possible applications will, of course, require confirmation by experimentation.

Addendum: It is our practice to distribute the medium in 500-cc. quantities in 1-l. flasks, sterilize, and store in the refrigerator until needed, at which time the agar is remelted and cooled to approximately 46°C. Streptomycin in sterile saline is then added and mixed thoroughly, and the agar is poured, 27–30 cc./plate. Plates of agar are left at room temperature 6–8 hours and then stored in the refrigerator. The poured agar appears transparent and light blue. In inoculating the medium, a generous quantity of sputum or fecal suspension in saline is vigorously spread over the surface of the agar using a sterile swab. Streaking by means of a wire loop is not required. Skin and nail scrapings and infected hairs are planted directly on the surface of the agar without preliminary treatment. Plates are incubated at room temperature, preferably at 30°C., but not at 37°C.

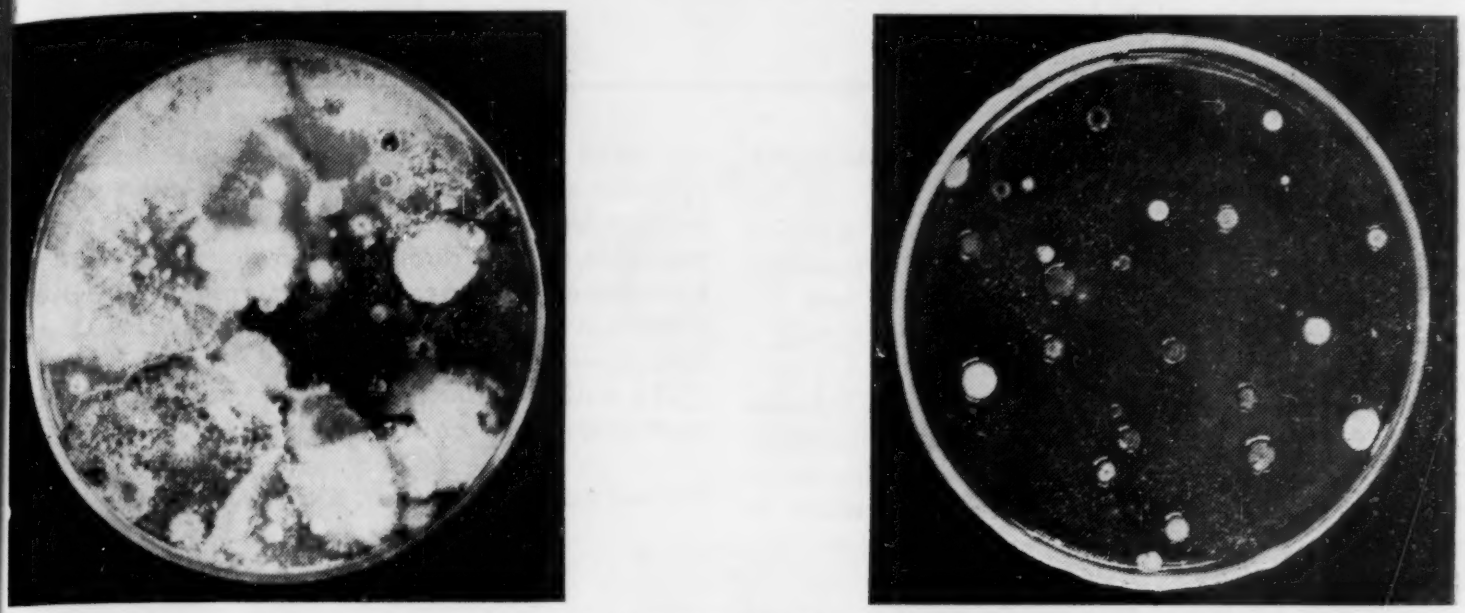

FIG. 1. Comparative appearance of media exposed to air for 4 hours, incubated 4 days at 30° C. *Left:* Sabouraud agar—marked spreading activity of aerial saprophytic fungi. *Right:* New medium—spreading activity reduced; note discrete, small colonies of fungi.

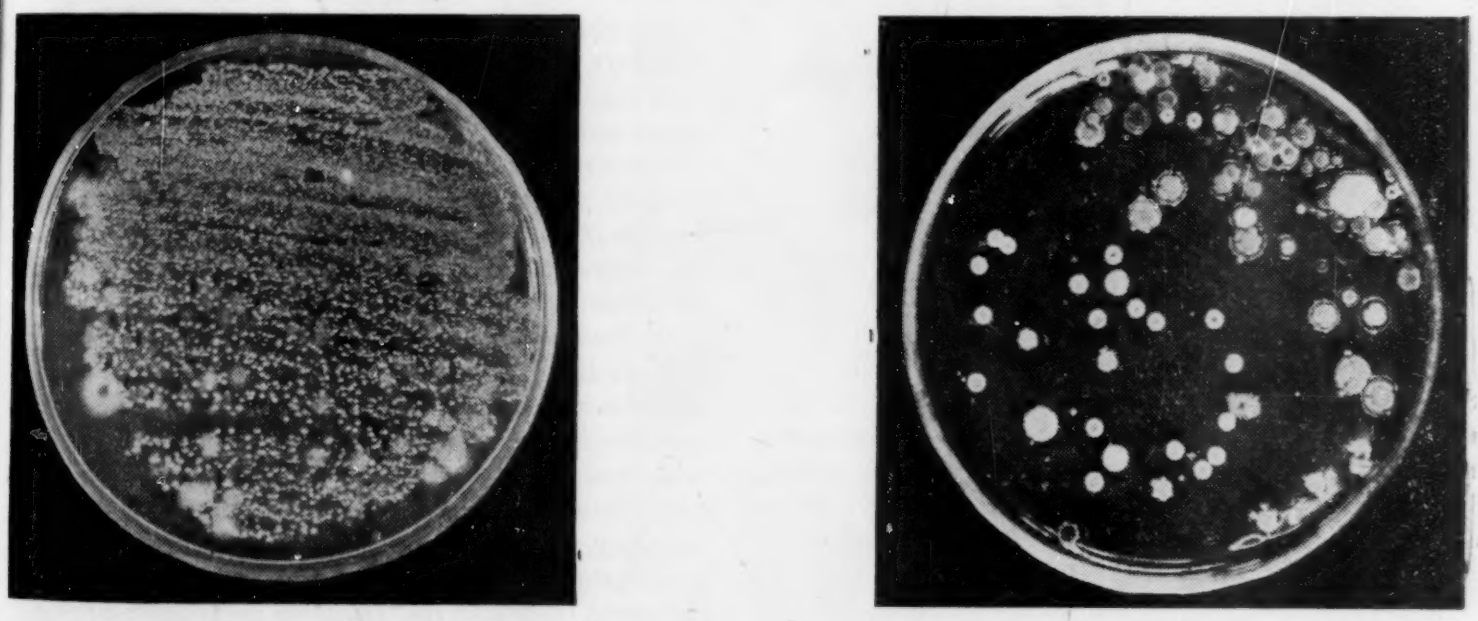

FIG. 2. Comparative appearance of media inoculated with heavy fecal suspension, incubated 4 days at 30° C. *Left:* Sabouraud agar—abundant bacterial growth which hindered fungal development. *Right:* New medium—minimal bacterial growth; note numerous, discrete, small colonies of fungi.

References

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Book Reviews

The Trematoda of British fishes. Ben Dawes. London: Ray Society, 1947. Pp. 364. (Illustrated.) 45/–.

The author's aim was to describe the trematodes of British fishes more fully than was possible in his book *The Trematoda* (*Science*, March 7, p. 268), but not to presume to treat the subject exhaustively. The author is to be credited with a laborious task well done.

Ninety species of monogenetic and 101 species of digenetic trematodes are listed by taxonomic groups. Some of the species are not known to occur in fish from British waters but are included because they occur in those from adjacent waters. In most cases the information for each species includes synonymy, a list of hosts, the location in the host, notes on geographical distribution, and a brief description of the species. Keys to 16 families in the Monogenea and to 17 families in the Digenea are provided. There is a bibliography of over 650 titles which reflects a thorough coverage of the pertinent literature, an alphabetical list of hosts, a list of hosts with their trematode parasites, and a general and systematic index.

This book may be considered as essentially a compilation of information from other sources, supplemented from first-hand experience with many of the species mentioned. Although the book is not a critical reference work on the subject, it will be of considerable value as a handbook and as a guide to the extensive literature on the subject.

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The rare-earth elements and their compounds. Don M. Yost, Horace Russell, Jr., and Clifford S. Garner. New York: John Wiley; London: Chapman & Hall, 1947. Pp. viii + 92. $2.50.

By monotonously laborious procedures of fractionation, the chemist achieved the separation and discovery of the rare-earth elements. Related chemically so closely, these puzzling elements did not fit into the then-existing periodic system. Their nature as well as the reason for their existence was hazy and confusing, and interest in them gradually waned almost to the vanishing point.

With the discovery and investigation of electrons, X-rays, and spectral lines, and the introduction of the quantum theory of atomic structure, combined with thermodynamics and statistical mechanics, the interesting magnetic and spectroscopic properties of the rare earths were explained, and the similar chemical behavior of these elements was clarified. A second shot of new life was recently injected into the rare earths through finding some of them as fission products of thorium and uranium, while nuclear research brought forward the concept of a second rare-earth-like series, beginning with Element 89 (actinium) and termed the actinide series.

The subject matter of the present monograph is divided into six chapters which discuss the electronic structures and oxidation states of the rare-earth elements, the paramagnetic properties and absorption spectra of rare-earth compounds, evidence for the existence of Element 61, separation of the rare earths, and their chemical and physical properties. Nuclear properties of the rare-earth elements, general physical constants, and the periodic system of the elements are given in three appendices.

The material of the book, carefully and critically chosen, constitutes reliable, modern information.

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The nature and prevention of the cereal rusts as exemplified in the leaf rust of wheat. (***Annales Cryptogamici et Phytopathologici,*** Vol. IV. Frans Verdoorn, Ed.) K. Starr Chester. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1946. Pp. xvi + 269. (Illustrated.) $5.00.

This book represents the first attempt to bring together and summarize in English the literature on the rusts of cereal crops in general and the leaf rust of wheat in particular. The author not only presents complete published information on various phases under discussion, but also makes a commendable effort to analyze, interpret, and coordinate masses of information, some of which is in mimeographed form or in reports and similar material seldom cited. Those interested in rust research will be particularly grateful for the excellent summary of the Russian rust literature which, due to the language difficulties and appearance in obscure journals, often is not accessible and therefore is not well known in the Western Hemisphere.

The book is primarily a treatise on the leaf rust of wheat, although the other cereal rusts sometimes are discussed as illustrations of similar phenomena in leaf rust. In 15 chapters the history, origin, distribution, host range, effect on host plant and yields, symptomatology, etiology, physiologic specialization, survival and development, dissemination, epiphytology, and control of leaf rust are discussed at length. Investigators will find the chapters on physiologic specialization and control by rust resistance particularly interesting. The author's suggestion that the number of differential host varieties be reduced, thereby reducing the number of physiologic races by grouping similar races, presents a concept often discussed by uredinologists but seldom mentioned in literature. This suggestion will be favored by some investigators and condemned by others.

A list of 423 articles on rust appears at the end, and special praise is due for an excellent job of summarizing and bringing rust literature up to date in a single publication readily accessible to students and investigators.

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